Cost Validation Using PRICE H

Presented to the PRICE Systems Estimating & Analysis Best Practice Workshop

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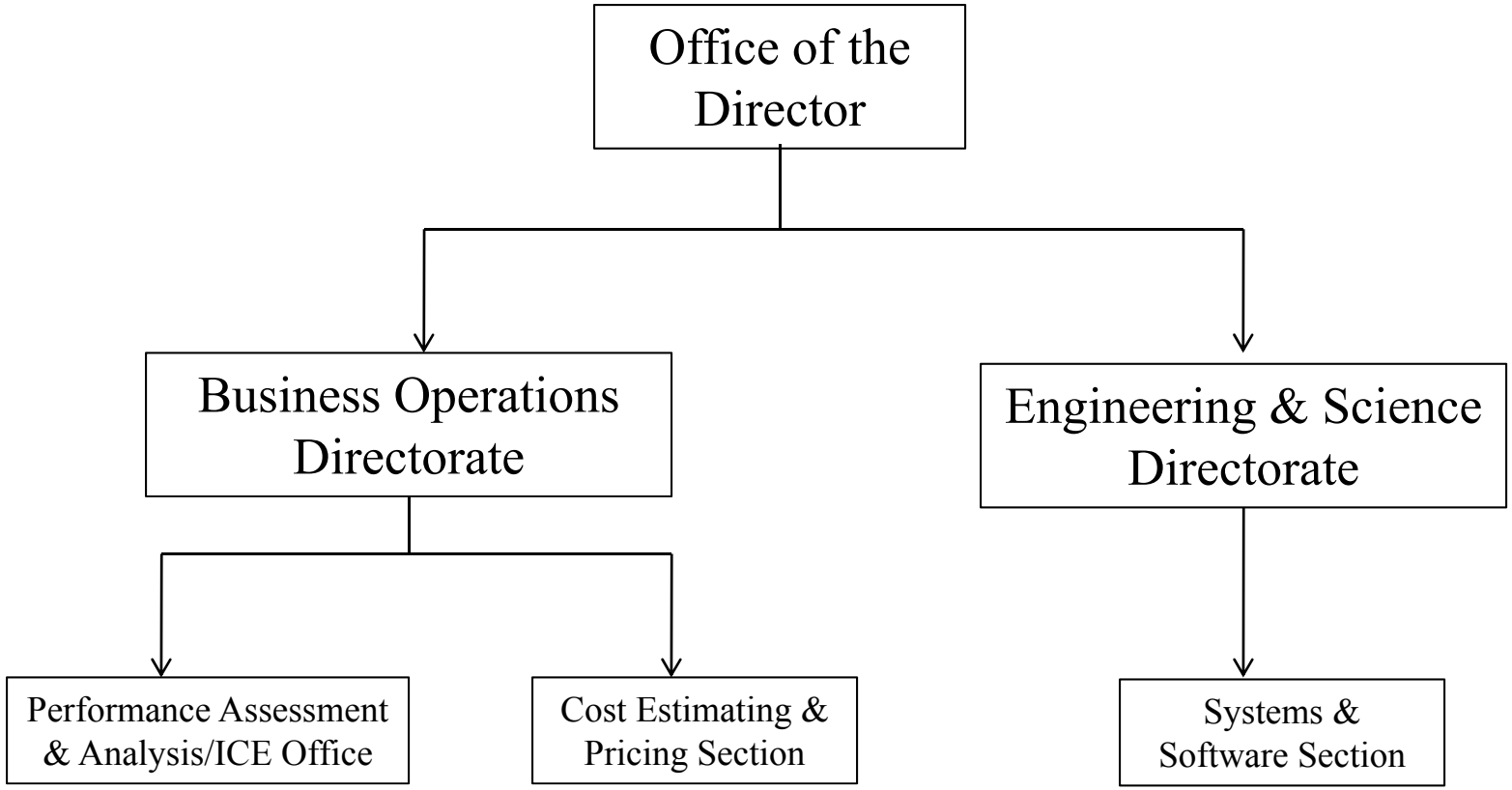
Agenda

- Background
  - History
  - Users
- PRICE H Calibration
- Application Examples
  - New Frontier
  - Discovery
  - Explorer
- Recommendation
- Open Discussion

Background

- PRICE H was introduced into the JPL cost estimation tool set in ~ 2003
- It became more available at JPL when IPAO funded the NASA-wide site license for all NASA centers
- PRICE H was mainly used as one of the cost tools to validate proposal grassroots cost estimates
- Program offices at JPL view PRICE H as an additional crosscheck to Team X (JPL Concurrent Engineering Design Center) estimates
- PRICE H became widely accepted ~ 2007 at JPL when the program offices moved away from grassroots cost estimation for Step 1 proposals
- PRICE H is now one of the key cost tools used for cost validation, cost trades, and independent cost estimates

PRICE Users at JPL



PRICE H Users at JPL Consist of Both Engineers and Business Professionals

How JPL Uses PRICE H

- Calibrated Mode
  - Proposal cost validation
    - Compare to CBE point estimate
  - Independent Cost Estimates (ICE)
  - Cost trades in early formulation/advance studies

- Non-Calibrated Mode
  - Unique spacecraft hardware with no direct analogy
  - In-Situ instruments and telescopes
  - Experimental payloads and spacecrafts

Other Models Used for Cost Validation

WBS	Cost Analogy	PRICE H	SEER H/S	NICM ver. IV	Wrap Factors	Burn Rates	Pass-thru	SOCM
PM / PSE / SMA					X			
Science							X	
Payload		X		X	X			
Spacecraft & System I&T	X	X	X		X			
MOS / GDS / Mission Design						X		X
EPO					X			

Multiple models provide confidence that the cost estimates are reasonable

JPL Calibration (1 of 3)

- Primary Cost Drivers:
  - The technology MCPLXS/E metric has been calibrated by subsystem to JPL missions to generate a “normalized cost” for part class B missions
  - Missions with parts class S are required to make adjustments to the MCPLXE factor to adjust for the additional testing/reliability requirement on electronic parts
  - Calibration results of MCPLX are used to determine nominal cost of a subsystem requiring typical drafting, design, systems, and subsystem management
  - Subsystems with highest MCPLX metric are Telecom, C&DH, ACS, and Power

JPL Calibration (2 of 3)

- Secondary Cost Drivers:
  - Established based on validation of the "nominal MCPLX" data set against historical missions
  - ECMPLX: Range of acceptable values for JPL: 1.0-2.2
    - Selection depends on personnel experience base, familiarity of personnel with similar types of projects, etc.
    - ECMPLX is set to 1.0 when the project is considered to have new design with normal experience base.
      - Most representative of missions like DAWN, MRO, Genesis, Stardust, and Juno.
    - ECMPLX from 1.3-1.5 is considered when the build is a new product and the workforce is of mixed experience base.
      - Most representative of missions like MER.
    - ECMPLX from 2.0- 2.2 is considered when the build is a new technology or state of the art product and the workforce is of mixed experience base.
      - Most representative of missions like Cassini/Galileo.

JPL Calibration (3 of 3)

- Secondary Cost Drivers:
  - Platform, Range for JPL Missions: 2.0 – 2.5
    - Typical JPL Planetary Missions should be set to 2.5.
    - Earth orbiting missions could be set to 2.0, depending on testing/reliability requirements.
  - NEWST/EL, Range for JPL Missions: 0.80 -1.0
    - Validation results have shown that most missions at JPL have little direct reusability as defined by PRICE-H.
    - Nominal setting for this parameter is set at 1.0.
    - Missions with more reusability, similar to MRO and Dawn, can set this parameter to 0.80.

Key Inputs for a Calibrated PRICE H Model

- Weight for the electronic and structure from the Mass Equipment List (MEL)

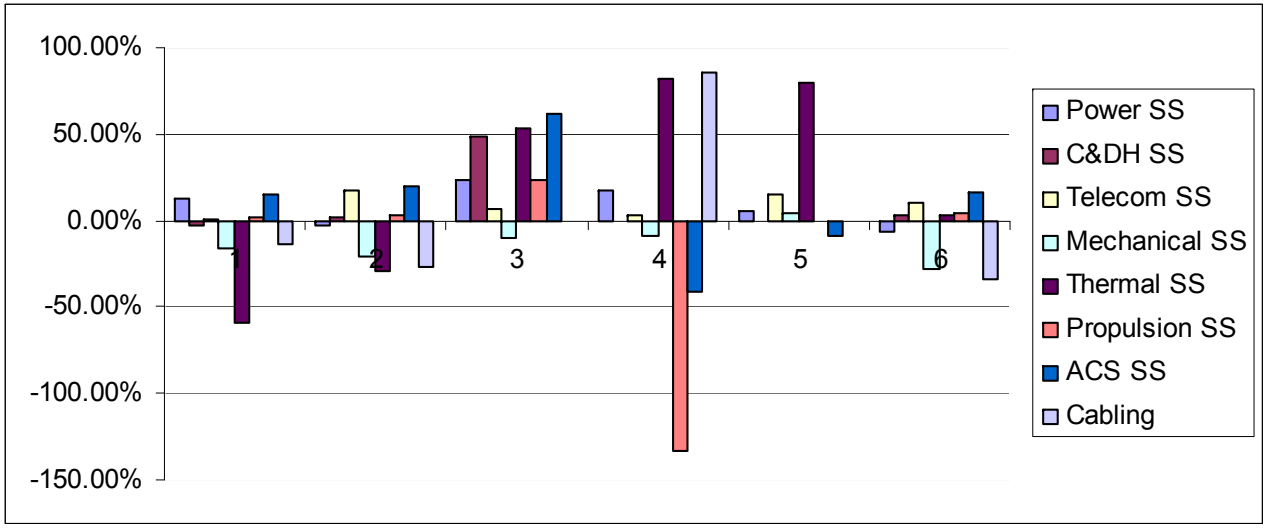
- Weight allocation for electronics and structure Rules of Thumb
  - If the mass is greater than 40 kg used 97% for WS.
  - If the mass is between 20 kg and 40 kg used 95% for WS.
  - If mass is less than 20 kg used 90% for WS.

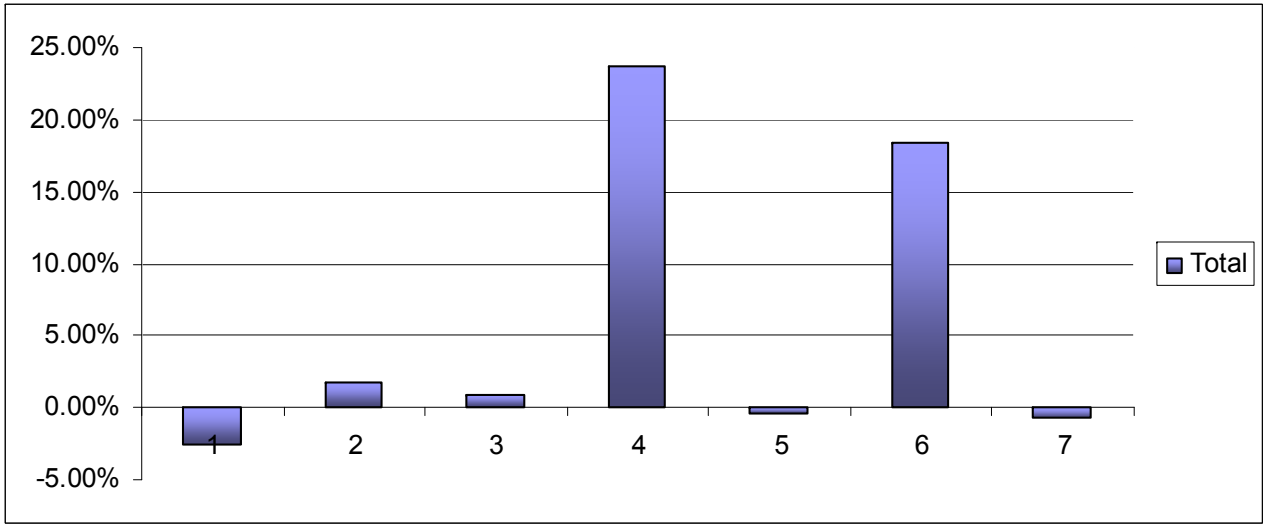
Application Examples

- Data Set:
  - DAWN, Genesis, Juno, MER, MRO, Phoenix, Stardust, Kepler, Spitzer, WISE, Deep Impact
- New Frontier Cycle
  - No dominant analogy from data set
  - Use "Nominal Value" for MCPLXS/E
  - Adjusted NEWST/ECMPLX based on % of new design assumption and experience base
- Discovery Cycle
  - More direct analogy with data set
  - Choose best analog from data set to represents the proposed mission
  - Primary (MCPLXS/E) and Secondary (NEWST/ECMPLX) parameters are derived from the chosen analog
  - Can vary analog at subsystem level if data is available
- Explorer Cycle
  - Direct analogy from data set
  - Best analogy was WISE for this class of small explorer missions
  - Used WISE data to derive Primary and Secondary PRICE H parameters

The PRICE H implementation approach depends on the available data, the applicability of the data to a new mission, and the resolution at which the new mission is being estimated.

Validation Results – Nominal Case





Recommendation

- Validation at the subsystem level produced very large ranges in cost: more than +/- 100%
- However, validation at the total level produces results with a much tighter range, within 25% of actual, with majority of the results falling within 5% of actual
- Thus, the model is used to validate cost at the total flight system level
- Using the model to validate/reconcile subsystem level estimates is not recommended due to the large variability in results.

Open Discussion